South Dakota School Of Mines & Technology
Mathematical Sciences Department

Math 374 HQ 1 Feb. 2, 2000

Place your answers on the answer sheet provided. Use a #2 pencil. Ink will NOT be detected by the scoring machine.

1. Which of the following is NOT one of the five steps to deriving a differential equation?
   A. Substitute the flux equation (i.e. Fourier's Law, Newton's Law of Viscosity, etc.)
   B. Make a sketch
   C. Divide by the independent Δ's and take the limit as they go to zero
   D. Use the BC's to evaluate C_1 and C_2

2. What is the shape of a differential element for a three-dimensional heat conduction problem in rectilinear coordinates (3D USS HT)?
   A. An infinite flat sheet Δx thick
   B. An infinitely long French-fry-shaped element with a cross section Δy by Δx
   C. A small cube Δx by Δy by Δz
   D. None of the above

3. What is the shape of a differential element for a heat conduction problem in a cylinder in which the temperature varies in both the radial and axial directions? No generation.
   A. A solid cylinder L long with
   B. A tube L long with a radius r and a wall thickness of Δr
   C. A ring Δz long with a radius r and wall thickness of Δr
   D. A thin disk Δz thick with a radius r

4. What shape of the differential element for a heat conduction problem involving a sphere in which the temperature varies with r?
   A. A solid sphere with radius Δr
   B. A solid sphere with radius r
   C. A spherical shell Δr thick with radius r
   D. A small element $\Delta\theta$, $d\phi\sin\theta$, by Δr at radius r.

5. What is the area through which the radial flux (r-dir) moves in a cylindrical element L long?
   A. πrL
   B. $2\pi rL$
   C. πr^2
   D. $2\pi r\Delta r$

6. What is the area through which an axial flux (z-dir) moves through a cylindrical element Δz.
   A. πr^2
   B. $2\pi r\Delta z$
   C. $2\pi r\Delta r$
   D. $2\pi rL$

7. What is the volume of a spherical differential in which r is the only independent position variable?.
   A. πr^3
   B. $4\pi r^2\Delta r$
   C. $2\pi rL\Delta z$
   D. $(4/3)\pi r^2\Delta r$

8. Which is the correct equation for a heat balance for a cylindrical coordinate heat conduction problem in which temperature varies in the radial direction only? No generation.
   A. $\left[(2\pi Lrq_r)|_r - (2\pi Lrq_r)|_{r+\Delta r}\right]\Delta t = 2\pi Lr\Delta r\rho Cp\left(T_{t+\Delta t} - T_t\right)$
   B. $2\pi Lr\left[(q_r)|_r - (q_r)|_{r+\Delta r}\right]\Delta t = 2\pi Lr\Delta r\rho Cp\left(T_{t+\Delta t} - T_t\right)$
   C. $2\pi L\left[(rq_r)|_r - (rq_r)|_{r+\Delta r}\right]\Delta t = \pi r^2 L\rho Cp\left(T_{t+\Delta t} - T_t\right)$
   D. None of the above

9. Which is the correct equation for a rectilinear coordinate heat conduction problem in which temperature varies in the x and y directions only? No generation. The solid is W wide (x-dir), H high (y-dir), and L long (z-dir).
   A. $\left[L\Delta y\left(q_x|_x - q_x|_{x+\Delta x}\right) + L\Delta x\left(q_y|_y - q_y|_{y+\Delta y}\right)\right]\Delta t = L\Delta x\Delta y\rho Cp\left(T_{t+\Delta t} - T_t\right)$
   B. $\left[W\Delta x\left(q_x|_x - q_x|_{x+\Delta x}\right) + W\Delta y\left(q_y|_y - q_y|_{y+\Delta y}\right)\right]\Delta t = W\Delta x\Delta y\rho Cp\left(T_{t+\Delta t} - T_t\right)$
   C. $\left[\Delta y\left(q_x|_x - q_x|_{x+\Delta x}\right) + \Delta x\left(q_y|_y - q_y|_{y+\Delta y}\right)\right]\Delta t = \Delta x\Delta yL\rho Cp\left(T_{t+\Delta t} - T_t\right)$
   D. None of the above

10. What is the definition of the derivative $\frac{dy}{dx}$?.
    A. $Lim\ as\ x \to 0\ \frac{y|_{x+\Delta x} - y|_x}{\Delta x}$
    B. $Lim\ as\ x \to 0\ \frac{y|_x - y|_{x+\Delta x}}{\Delta x}$
    C. $Lim\ as\ x \to 0\ \frac{y|_{x+\Delta x} - y|_x}{\Delta y}$
    D. None of the above

Correct Answers: 1-D 2-C 3-C 4-C 5-B 6-C 7-B 8-A 9-A 10-D

Adjustments: #6 could be A since it was not specified that there was any change in the r direction
#8 20% credit will be given for B if you promise to never make that mistake again
#10 50% credit will be given for A since it is correct except for no delta in the limit